U.S. Department of Transportation

Alternative Solutions to Railroad Impacts on Communities

Summary Report

October 1981

TECHNOLOGY SHARING REPRINT SERIES

Prepared for:
Minnesota Department of Transportation
North Dakota State Highway Department

ALTERNATIVE SOLUTIONS TO RAILROAD IMPACTS ON COMMUNITIES

SUMMARY REPORT

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FOR

MINNESOTA DEPARTMENT OF TRANSPORTATION
NORTH DAKOTA STATE HIGHWAY DEPARTMENT

OCTOBER 1981

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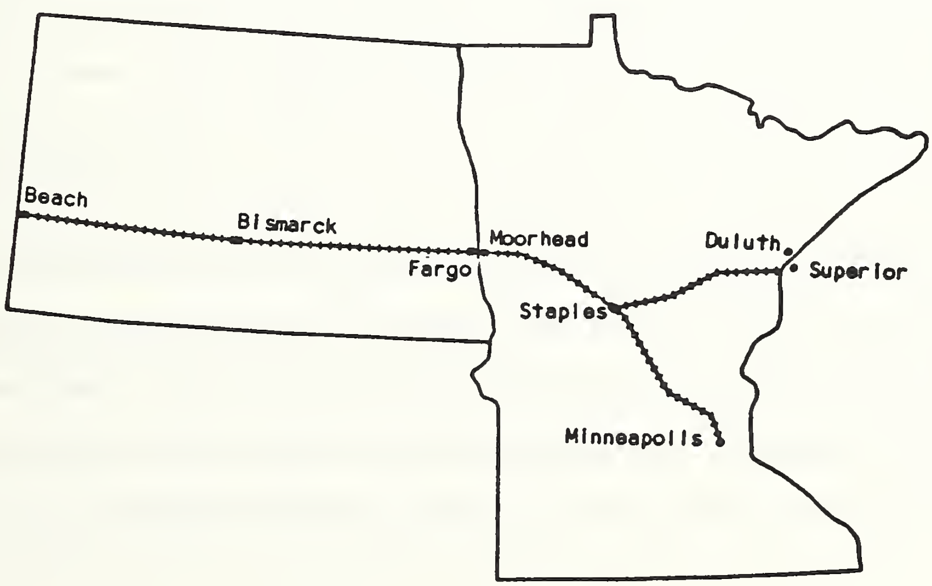
FINAL SUMMARY REPORT

BACKGROUND

This report presents the results of a study, known as the Rail Corridor Study, which identifed community problems arising from conflicts between railroad operations and community activities and evaluated low-cost remedial actions. The study was initiated as a result of (1) the formation and activities of the Rail Traffic Task Force, a voluntary group of Minnesota and North Dakota communities organized in 1976 to identify and resolve railroad/community conflicts, and (2) the increasing national significance of the coal train impact issue as domestic consumption and U.S. coal exports increase. The study corridor, shown in Exhibit 1, is the area along a Burlington Northern, Inc., (BN) main line in Minnesota and North Dakota.

EXHIBIT 1

THE STUDY CORRIDOR



Rail Traffic Task Force members recognize that Burlington Northern, Inc., has had a substantial, positive effect on the approximately 80 communities located along the corridor, for many years serving as a major employer and providing essential freight transportation links to the rest of the country. The railroad continues to play a vital role in the development and well-being of these communities.

On the other hand, the presence of the railroad main line within communities and local rail operations conflict often with community activities and development. The Task Force contends that the increase in coal traffic in the corridor has intensified the conflicts. There is concern that if projected increases in coal traffic occur, the conflicts will become even more serious. The concerns and actions of the Task Force are largely responsible for initiating this study.

The efforts of the Task Force and the commitment of the states of Minnesota and North Dakota and the Burlington Northern, Inc., to address community problems attracted the attention of the U.S. Departments of Energy and Transportation. The Departments saw an opportunity to conduct a prototype study of community impacts of railroad operations, particularly of unit coal train operations. As coal has come to play a more significant role in meeting the nation's energy requirements, the community impacts of increased unit coal train movements have become a growing concern of the federal government. Consequently, the U.S. Departments of Energy and Transportation joined the Minnesota Department of Transportation, the North Dakota State Highway Department, Burlington Northern, Inc., and the Rail Traffic Task Force in jointly sponsoring this study. A study Management Board, on which each study participant was represented, was responsible for policy guidance and approval of study results and products.

STUDY OBJECTIVE AND APPROACH

The study objective was to identify and evaluate low-cost solutions to problems associated with railroad/community conflicts occurring along the study corridor. To accomplish this objective, a three-phase work program was conducted:

- In Phase I, a corridor-wide survey of rail/community conflicts was made. Problems were identified by community and a preliminary list of low-cost actions deemed to be potential solutions was developed.
- In Phase II, an in-depth analysis of problems in six representative corridor communities was conducted. Alternative low-cost actions to resolve the problems were identified and analyzed. Phase II culminated with selection of remedial actions to be implemented in each case study community as demonstration projects. Funding sources for the project also were investigated.
- In Phase III, the demonstration projects were implemented and evaluated. The purpose of this phase was to establish the actual effectiveness of the projects in resolving problems and to determine the projects' applicability to other corridor communities.

This report summarizes the findings of the study. Separate reports documenting the results of Phases I and II are available on request from the Minnesota Department of Transportation, as are technical reports providing detailed information on the methodology and results of each study phase.

CORRIDOR-WIDE SURVEY

In Phase I of the study, information on rail/community conflicts was obtained for 47 of the 77 rail corridor communities. The information was obtained through a mail survey of 12,000 randomly selected corridor residents, personal interviews with local, state, and railroad officials, public meetings, and field observations.

It was learned that the following seven basic types of problems were experienced in corridor communities as a result of rail/community conflicts:

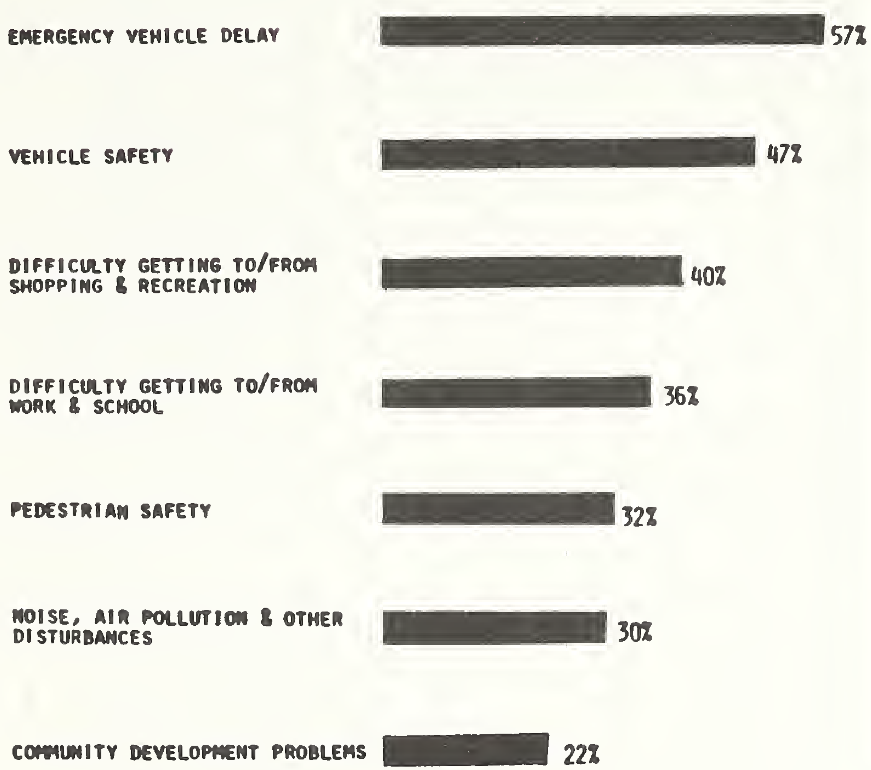
- Pedestrian safety
- Vehicle safety
- Emergency vehicle delay
- Delays in traveling to and from work and school
- Delays in traveling to and from shopping and recreation
- Noise, air pollution, and other environmental disturbances
- Community development problems such as inhibition of economic or residential growth, distribution of economic activity away from preferred locations, and reduced community attractiveness.

Corridor-wide, delay to emergency services and vehicle safety were perceived to be the most serious problems (see Exhibit 2). However, communities varied considerably in terms of problems encountered and the relative severity of those problems. For example, 74 percent of one community's respondents to the mail survey stated that delays to emergency services was a serious problem in their community. In another community, only three percent of the respondents believed emergency service delays to be a serious problem. Similar ranges in responses by communities were found for all problems. Another important Phase I finding was that the relatively serious problems are not concentrated in a small group of communities. Rather, the list of most severely affected communities varied by problem type. All communities, for which data were obtained, experienced at least one problem. Many of the communities experienced several problems.

EXHIBIT 2

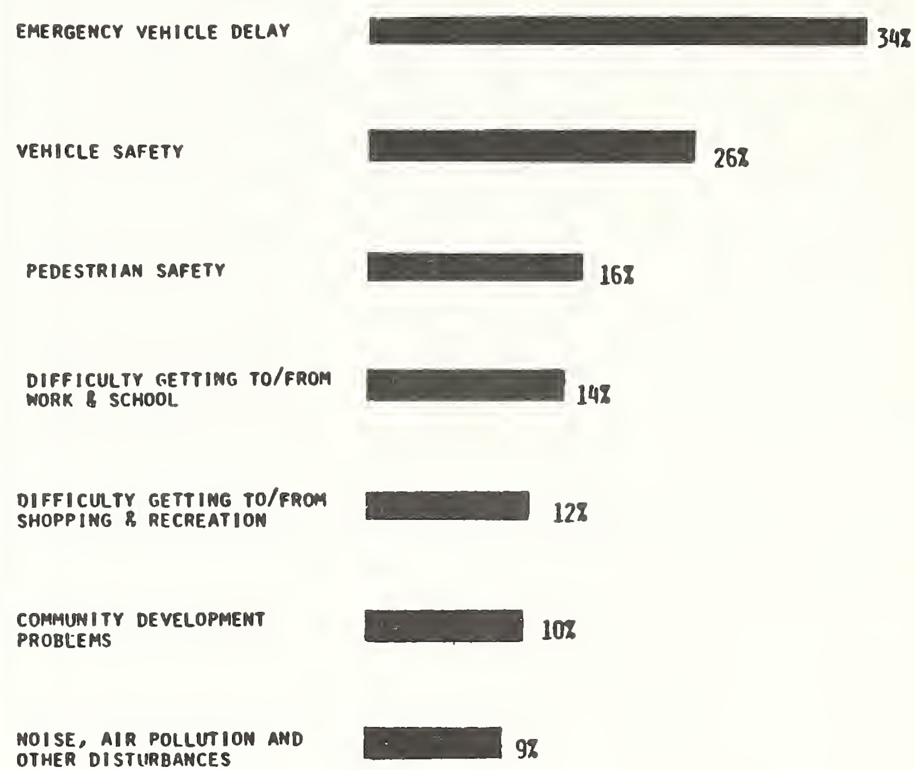
RESPONSES TO THE PHASE I MAIL SURVEY

PROBLEMS CITED BY CORRIDOR COMMUNITIES
(PERCENT OF RESPONDENTS WHO PERCEIVE A PROBLEM TO EXIST)



SOURCE: ERNST & ERNST SURVEY OF STUDY CORRIDOR RESIDENTS; DECEMBER, 1978 - FEBRUARY, 1979

PROBLEMS CITED BY CORRIDOR COMMUNITIES
(PERCENT OF RESPONDENTS WHO PERCEIVE A PROBLEM TO BE SEVERE OR VERY SEVERE)



SOURCE: ERNST & ERNST SURVEY OF STUDY CORRIDOR RESIDENTS; DECEMBER, 1978 - FEBRUARY, 1979.

CASE STUDIES

The purpose of Phase II of the study was to develop a better understanding of community problems resulting from rail/community conflicts and to identify potential low-cost solutions. The approach entailed an in-depth analysis of problems and alternative solutions in six case study communities:

- Beach, North Dakota (population 1,400)
- Casselton, North Dakota (1,800)
- Elk River, Minnesota (7,000)
- Hebron, North Dakota (1,100)
- Moorhead, Minnesota (30,000)
- Sauk Rapids, Minnesota (5,800)

The communities are representative of other corridor communities in terms of characteristics, problems, causes of problems, and potentially effective low-cost solutions.

Problems Confronting the Communities

The case studies focused on the problems designated as priorities by each community. The problems investigated included emergency vehicle delays; vehicle and pedestrian safety; access problems in traveling to and from work, school, business, and shopping; and community development constraints. Environmental disturbances were not investigated. Although some residents perceived environmental disturbance as a serious problem, most residents considered it a relatively minor one. None of the case study communities designated it as a priority problem area. Problem designations by community are indicated in Exhibit 3.

EXHIBIT 3

CASE STUDY COMMUNITY PRIORITY PROBLEMS

CASE STUDY COMMUNITY	PRIORITY PROBLEMS						
	EV	VS	PS	AWS	ABS	CD	EN
Beach, ND	X	X	X	X			
Casselton, ND	X	X	X				
Elk River, MN	X	X		X			
Hebron, ND	X	X	X	X	X		
Moorhead, MN	X			X		X	
Sauk Rapids, MN	X	X					

KEY

EV = Emergency Vehicle Delay
VS = Vehicular Safety
PS = Pedestrian Safety
AWS = Access to Work/School
ABS = Access to Personal Business/Social Activities
CD = Community Development
EN = Environment

An "X" designates the problems identified by community residents and officials as priority concerns.

Estimates of Problem Magnitudes

Estimates of the magnitudes of priority problems in each community were made to quantify the repercussions of rail/community conflicts and to provide the basis for evaluating remedial actions. The estimates are presented in Exhibit 4.

The estimates which represent community totals suggest a wide range of experience. When the estimates are put in per capita terms, however, relative problem magnitudes among communities are less diverse. Also, the rank order of communities by problem magnitude changes when per capita rather than community-wide estimates are used, as can be seen in Exhibit 5. These comparisons show that small communities may have more severe rail/community conflicts than larger communities and illustrate the importance of using per capita as well as community estimates when evaluating problem severity in and among communities.

Railroad Operating Characteristics

An important component in estimating problem magnitudes and in identifying remedial actions is the profile of railroad operating characteristics. Exhibit 6 presents some of these characteristics for the case study communities prior to implementation of demonstration projects.

A review of operating characteristics points to a significant conclusion. Rail/community conflicts are not solely related to the number of train operations conducted in a community. The conflicts derive from the types of railroad operations conducted and from the characteristics of the community as well. For example, while both Elk River and Sauk Rapids experience 25 trains on the average day, the percentage of the day that

EXHIBIT 4

ESTIMATES OF CURRENT PROBLEM MAGNITUDES IN CASE STUDY COMMUNITIES 1/

Community	EMERGENCY VEHICLE DELAYS PER YEAR			AUTO/TRAIN ACCIDENTS	ACCESSIBILITY (DELAY PER YEAR AT CROSSINGS			COMMUNITY DEVELOPMENT (DELAY AT CROSSINGS PROVIDING ACCESS TO THE CBD)		
	Ambulance 2/	Fire	Police	PER YEAR	Vehicles	Vehicle Hrs.	Person Hrs. 3/	Vehicles	Vehicle Hrs	Person Hrs
Beach, ND	12.5	0.0	--	0.7	84,000	3,700	5,200	NA	NA	NA
Casselton, ND	20.0	0.8	--	0.8	125,000	3,700	5,200	NA	NA	NA
Elk River, MN	18.0	10.0	--	0.3	245,000	9,800	13,700	NA	NA	NA
Hebron, ND	5.3	1.7	--	0.5	44,000	1,900	2,700	NA	NA	NA
Moorhead, MN	91.0	27.0	300.0	2.5	840,000	36,000	50,300	560,000	22,700	32,700 4/
Sauk Rapids, MN	33.0	0.7	--	1.0	284,000	5,700	7,900	NA	NA	NA

1/ Please note that these are estimates of the order of problem magnitude. The estimates appear reasonable but are not statistically verifiable. Also, NA is not applicable; blank spaces mean that a reasonable estimate of problem magnitude could not be developed. No credible estimate of potential pedestrian/train accidents could be developed. Consequently, this problem area is excluded from this exhibit.

2/ It is not possible to estimate with any confidence how many of these delays may be critical to the patient. Previous research suggests that about five percent of the patients confront a life-threatening situation prior to receiving medical attention; about one percent of the patients traveling to the hospital confront a life-threatening situation. However, it is not possible to determine in how many of these cases a delay of the character estimated for these communities will be critical. No critical delays to date have occurred in any of the communities to our knowledge.

3/ Assumes 1.4 persons per vehicle.

4/ Includes delays to transit users.

5/ Residents also are concerned about the safety hazard at the intersection of a local street and a trunk highway created by traffic congestion at the nearby grade crossing during train operations. Average accident experience is 8 per year at this intersection.

6/ Because the equations used to estimate auto/train accidents are based on national data, and due to the difficulties associated with estimating grade crossing accidents, the estimates must be regarded as representing the order of magnitude of what may occur in the communities. They should not be regarded as accurate predictions of what will inevitably occur.

EXHIBIT 5

PER CAPITA MAGNITUDE OF SELECTED CASE STUDY COMMUNITY PROBLEMS

	PER CAPITA PROBLEM MAGNITUDE 1/ (Number Per Average Year)		
Community	Ambulance Delays	Vehicles Delayed	Auto/Train Accidents
Beach, ND	.0083	56	.0005
Casselton ND	.0111	69	.0004
Elk River, MN	.0026	35	.0001
Hebron, ND	.0048	40	.0004
Moorhead, MN	.0030	28	.0001
Sauk Rapids, MN	.0056	48	.0002

1/ Community populations are:

Beach	1,400
Casselton	1,800
Elk River	7,000
Hebron	1,100
Moorhead	30,000
Sauk Rapids	5,800

EXHIBIT 6

RAILROAD OPERATIONS IN THE CASE STUDY COMMUNITIES

(Pre-Demonstration Projects)

Case Study	Trains Per Day 1/ Average	Trains Per Day 1/ Range	Ave. Length (cars)	Speed (mph) Average	Speed (mph) Range	Operations 2/	% of Day Crossings Are Blocked 3/
Beach, ND							
Coal	12	0-17	104				4.1
Mixed Freight	3	0-11	80	N/A	N/A		0.9
Local	1	0-3	10				0.4
Total	16	1-23	90	27	13-45	T,S,M.CB,O	5.4
Casselton, ND							
Coal	9	2-16	104	28	15-45		2.3
Mixed Freight	18	11-26	82	24	5-45		5.4
Local	4	0-5	12	5	1-10		1.9
Total	31	25-42	84	24	1-45	S,M,O,I,CB,T,A	10.4
Elk River, MN							
Coal	3	2-9	106	27	17-37		1.0
Mixed Freight	18	14-28	83	25	6-42		4.3
Local	4	1-7	11	6	3-14		3.0
Total	25	23-36	83	22	3-42	T,S,I,O,A	8.4
Hebron, ND							
Coal	12	1-18	104				3.9
Mixed Freight	3	3-12	80	N/A	N/A		1.3
Local	1	0-3	10				0.8
Total	16	6-25	89	35	6-44	T,S,M,CB,O	6.0
Sauk Rapids, MN							
Coal	3	1-12	106	40	10-45		0.5
Mixed Freight	20	12-29	83	38	9-50		3.3
Local	2	0-4	11	21	5-40		0.2
Total	25	13-45	83	38	5-50	T,M,I	4.1
Moorhead, MN (NP line)							
Coal	6		104	20	11-25		1.4
Mixed Freight	13		82	20	1-25		3.5
Local	2		12	24	1-25		0.4
Total	21		84	22	1-25	S,T	5.8
(GN line)							
Coal	2		104	11	1-25		0.8
Mixed Freight	4		82	15	1-25		1.1
Local	2		12	16	1-25		1.0
Total	8		84	14	1-25	S,T	3.4
(21st Street)							
Coal	7	2-12	104	21	6-25		2.0
Mixed Freight	17	13-22	82	17	6-25		4.6
Local	2	0-5	12	18	1-25		0.9
Total	26	23-36	84	18	1-25	S,M,O,I,T,A	7.5

1/ Represents the numbr of trains operating in the community per day, not the number of operations conducted by trains per day. Thus, a train that enters and exits a crossing more than once per day is counted only once. The estimate of blocked crossing time, however, accounts for multiple operations by a single train.

2/ Operations conducted include switching (S), train meets (M), receipt of orders (O), inspection (I), crew breaks (CB), testing (A), through movements (T).

3/ Totals may exceed the sum of blocked time by train type due to crossings closed (i.e., signals activated) in the absence of a passing train.

crossings are blocked on average in Elk River is twice that of Sauk Rapids. The difference is in types of trains, types of operations, and train speeds.

As noted, community characteristics also are an important determinant of the magnitude of rail/community conflicts. Using the Elk River/Sauk Rapids example, in which blocked crossing time in Elk River is twice that of Sauk Rapids, it would seem that problem magnitudes would be larger in Elk River. This is not the case, however, because Sauk Rapids' development patterns cause community activities to conflict more frequently with train operations than those in Elk River (see Exhibits 4 and 5).

These comparisons verify the Phase I conclusion that community problems experienced along the corridor result from the interaction of railroad operations and community characteristics; they are not caused solely by railroad activities. The comparisons also reveal that simple indices of rail operations (such as train volumes) and community characteristics (such as population or daily traffic volumes) may distort an accurate assessment of absolute and relative problem magnitude among communities.

<u>Effects of Unit Coal Trains on Community Problems</u>

The adverse community impacts of unit coal trains is of particular concern to communities in the study corridor as well as to communities in other corridors that currently experience or are projected to experience large volumes of unit coal trains. The case study analyses indicate that coal trains indeed contribute to the magnitude of problems experienced. More specifically, the railroad's contribution to delay-related problems attributable to coal trains in each case study community is approximately as follows:

Beach, North Dakota -- 75%
Casselton, North Dakota -- 25%
Elk River, Minnesota -- 12%
Hebron, North Dakota -- 60%
Moorhead, Minnesota -- 25%
Sauk Rapids, Minnesota -- 12%

As discussed earlier, the differences among communities are functions of the number and type of coal train operations relative to other train operations.

The number of coal trains operating in the corridor will continue to increase. This will contribute, along with further growth in corridor communities, to a worsening of rail/community conflicts. But a dramatic worsening of the conflicts will not occur in the near term, as some have predicted. Current projections indicate that there may be no increase by 1985 over 1980 levels in unit coal trains through Beach and Hebron, largely due to the rerouting of some trains on other BN main lines. The other case study communities may experience an increase of one to three unit coal trains per day by 1985. There also may be some additional mixed freight trains on the main line east of Casselton. Based on these projections and projections of community growth, Casselton and communities east would experience an increase in delay-related problems of 5 to 20 percent by 1985, if no mitigating actions were taken. Applying these percentage increases to estimated current problem magnitudes indicates that an important, but not substantial, increase in that magnitude may occur by 1985. The greater uncertainty associated with projections beyond 1985 makes estimates of rail/community conflicts farther into the future more conjectural.

Grade-separated crossings and rail relocation often are proposed as solutions to rail/community conflicts, but both are very expensive. In Moorhead alone, a set of nine grade separations were estimated to cost over $28 million in 1975.1/ In Sauk Rapids a single grade separation was estimated to cost $6 million in 1980.

Rail relocation is even more expensive. The average capital cost of rail relocations sponsored by the Federal Highway Administration as demonstration projects in 12 cities was $55 million in 1980. The cost range was $3 million to $114 million. These estimates do not include additional railroad operating cost that could result from the rerouting of trains. 2/

The cost of grade separations or rail relocation in a single community is high. The cost of applying these solutions on a corridor- or state-wide basis is enormous. There are almost eighty communities in the corridor studied, and it is only one of several in the nation that deserve attention to alleviate rail/community conflicts. Thus, the focus of this study was on identifying low-cost ways to resolve conflicts.

Identification of Low-Cost Alternatives

The identification of low-cost alternatives began in Phase I with the development of a list of actions thought to be low in cost and capable

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1/ Metropolitan Auto-Rail Study, Fargo-Moorhead Metropolitan Council of Governments, prepared by Bather-Rinrose-Wolsfeld, 1975.

2/ Information provided by the Railroads and Utilities Branch of the Federal Highway Administration, Washington, D.C., April 1980.

of mitigating rail/community conflicts. During the Phase II case studies, this list was expanded. The actions identified included changes in rail facilities and operations, changes in community services and facilities, establishment of railroad/community communication systems, public education programs, and redirection of community development patterns. A list of alternatives was compiled for each community.

The alternatives were analyzed for their worth as demonstration projects in four steps. First, the alternatives were screened; those determined to be unfeasible, ineffective, or of no demonstration value were eliminated. Second, the remaining alternatives were compared in terms of potential problem-solving effectiveness, implementation cost, institutional considerations, and effects on other problems and community or railroad conditions. Third, the results of the analyses were presented to the case study communities to determine which were acceptable or unacceptable for implementation and to determine the priority ranking for the acceptable actions. Finally, the Management Board selected the actions warranted for implementation as demonstration projects based on the information generated in the previous three steps. Exhibit 7 lists the actions investigated and the problems each was designed to address. In the last column, the exhibit designates the actions selected for implementation as demonstration projects.

Evaluation of the Demonstration Projects

The following pages contain a brief description of each demonstration project, the communities in which it was implemented, its effectiveness in reducing rail/community conflicts, and its implementation cost.

EXHIBIT 7

ACTIONS INVESTIGATED AS POTENTIAL LOW-COST SOLUTIONS TO THE PRIORITY PROBLEMS IN THE SIX CASE STUDY COMMUNITIES

ACTION	PROBLEMS THE ACTIONS ARE DESIGNED TO ADDRESS IN THE CASE STUDY COMMUNITIES						SELECTED FOR DEMON-STRATION
	EV	CD	AWS	ABS	VS	PS	
RAILROAD OPERATING CHANGES							
Ensure standing trains do not unnecessarily activate the gates and flashers by stopping the trains short of the activation circuit, thereby eliminating unnecessary delays at crossings.		X	X	X	X		
Increase maximum allowable train speed through communities to reduce the amount of time crossings are blocked and vehicles delayed.	X	X	X	X			X
Ensure that trains using sidings stop well clear of the crossings to avoid unnecessary crossing blockage and to avoid creating a visual obstruction of other approaching trains on parallel tracks.	X		X	X	X		
Schedule local switching operations to off-peak hours to reduce the number of motorists who will experience crossing delays.		X	X	X			
Allow delayed vehicles to clear the crossing periodically while switching operations are being conducted.			X	X			
Break trains that must straddle crossings for several minutes to avoid excessive vehicle delays.	X		X	X			
Redistribute trains from one mainline to another; the mainlines are parallel but separated by a few hundred feet; the mainline to which trains would be distributed affects fewer people than the other.		X	X	X			
Relocate crew change points outside of or farther from the community to reduce the crossing delays associated with stopping the train.	X	X	X	X			
Reroute trains around communities using existing tracks.	X	X	X	X			
Relocate the train verifier farther from the community to eliminate slow train speeds in the community as the by-check operation is conducted.	X	X	X	X			
RAILROAD FACILITY CHANGES							
Install grade crossing predictors to activate the gates at crossings in order to reduce early signal activation, thus reduce delays and hazards at crossings.	X	X	X	X	X	X	X
Extend crossing gate arms to prevent motorists from crossing the mainline when the gates are down.					X		
Install automatic gates at crossings in place of less effective grade crossing protection devices.					X		X
Alter rail sidings to eliminate blockage of crossings while trains use the sidings and to permit faster train speeds through the community while entering/exiting sidings.	X		X	X	X		X
Construct fencing along rail right-of-way to inhibit pedestrians from crossing at unprotected locations.						X	
Straighten track alignment to permit faster train speed through the community.	X	X	X	X			
Improve maintenance of the grade crossing surface.					X		
COMMUNITY FACILITY CHANGES							
Implement street and highway improvements designed to reduce delays at crossings and nearby intersections congested by vehicles delayed at crossings.			X	X	X		X
Remove visual obstructions along the rail right-of-way near crossings.					X		
Close selected hazardous highway/rail grade crossings.					X		X
Construct new crossings at both ends of the community as alternative routes for emergency vehicles only.	X						
Construct a grade-separated pedestrian crossing.						X	

EXHIBIT 7 (continued)

ACTIONS INVESTIGATED AS POTENTIAL LOW-COST SOLUTIONS TO THE PRIORITY PROBLEMS IN THE SIX CASE STUDY COMMUNITIES

ACTION	PROBLEMS THE ACTIONS ARE DESIGNED TO ADDRESS IN THE CASE STUDY COMMUNITIES						SELECTED FOR DEMON-STRATION
	EV	CD	AWS	ABS	VS	PS	
COMMUNITY SERVICE CHANGES							
More strictly enforce laws against crossing the tracks, violating activated warning signals.					X		
Upgrade ambulance service from a basic life support to an advanced life support system; this increases the ability to stabilize patients at the emergency scene and thus reduces the probability that a delay in traveling to the hospital will be critical.	X						
Equip fire service volunteers with personal equipment to conduct emergency operations prior to engine company arrival, thus reducing the adverse effects of crossing delay to the engine company.	X						
Establish emergency services on both sides of the mainline.	X						
Provide ambulance and fire service vehicles on both sides of the mainline.	X						
Relocate the emergency stations to the side of the mainline on which the majority of emergency calls occur, thus minimizing potential delays.	X						
Reroute school buses to avoid more hazardous crossings.					X		
Use alternative routes to respond to emergencies when first choice crossings are blocked by slow-moving or standing trains.	X						
Establish a volunteer rescue squad to complement the existing ambulance service and to provide emergency medical service stations on both sides of the mainline.	X						X
Establish a volunteer ambulance service to complement the existing private service and to provide emergency medical service stations on both sides of the mainline.	X						
Redesign transit bus routes to minimize times the mainline must be crossed.		X	X				
PUBLIC EDUCATION							
Institute pedestrian safety patrols for the safety of children crossing the mainlines on their way.						X	X
Conduct a marketing campaign to overcome people's perceptions of significant access problems to business centers.		X					
Conduct a pedestrian safety education program in the schools.						X	X
COMMUNICATIONS							
Establish an emergency service/railroad communication system to provide the capability to alter train operations and avoid blocking designated crossings in emergency situations.	X						X
Improve general community/railroad communications.	X	X	X	X	X	X	X
COMMUNITY DEVELOPMENT							
Direct new development in a way that will minimize future rail/community conflicts.	X	X	X	X	X	X	

KEY:

EV = Emergency Vehicle Delay
VS = Vehicular Safety
PS = Pedestrian Safety
AWS = Access to Work/School
ABS = Access to Personal Business/Social Activities
CD = Community Development
EN = Environment

Emergency Service/Railroad Communication System. Establishment of an emergency communication system is being tested in Casselton, Elk River, Moorhead, and Sauk Rapids. The purpose of the system is to circumvent or to minimize emergency service delays at crossings. The system functions as follows:

> A private telephone line, dedicated to communicating the need to cross the main line to respond to a medical, fire, or police emergency, has been installed in the local railroad agent's (or the train dispatcher's) office. Only the designated local emergency service provider(s) know(s) the private telephone number. The emergency service provider uses the phone to inform the agent of emergency calls that require crossing the main line. The agent is called only in situations in which a delay in response may adversely affect emergency outcome. Having been notified of an emergency, the agent determines the necessity and feasibility of changing train operations in or near the community to avoid blocking the predesignated emergency crossing. According to preestablished guidelines, the agent instructs train crews, via the established radio communication system, to change train operations accordingly (e.g., slow down, speed up, or stop). Both the agent and the emergency service provider record the communication and its outcome.

The cost to establish and maintain the communication systems is small. Phone installation cost is about $90 and the monthly service charge is about $20. These costs are being paid by Burlington Northern. In the one case in which the phone is located in the train dispatcher's office rather than the local agent's office, a long-distance charge is incurred by the emergency service provider for each call.

The emergency communication systems were established only within the last month or two. This is not a sufficient period of time for evaluating the systems. While the phones have been used several times, no alteration of train operations has been necessary to date. Prior to implementation of the projects, it was estimated that up to 100 percent of the potential emergency service delays at crossings could be eliminated by the communication system. The projects will continue to be monitored to determine actual effectiveness.

Rescue Squad. Establishment of a rescue squad was recommended for Sauk Rapids to reduce delays at crossings in responding to medical emergencies. The project was not implemented because funding (up to $25,000 for a vehicle and $2,000 for annual operating costs) was not obtained. In Moorhead, however, a rescue squad was established within the fire department as a component of the emergency service system in 1976. Moorhead's system provides insight into how a rescue squad can circumvent delays at rail/highway crossings.

A rescue squad consists of people trained in basic emergency medical techniques and provided with medical supplies and equipment. The rescue squad provides a first-response capability only. It is not licensed to transport patients. The squad can treat the patient at the emergency scene until the ambulance service arrives. Thus, by locating the squad on the side of the main line opposite the ambulance service, emergency service can be promptly provided even if the ambulance service is delayed at a crossing.

The rescue squad has definite economic advantages over establishing duplicate ambulance services. The cost is considerably less. An investment of $70,000 may be required to establish a second ambulance service, but a rescue squad will cost $10,000 to $25,000, depending on the equipment purchased. Annual operating costs for the proposed Sauk Rapids volunteer squad would have cost from $1,000 to $3,000. Sixty to one hundred hours of training are required for personnel.

In Moorhead, the principal medical emergency service is provided by a private ambulance service. Through radio communication between the dispatcher and the ambulance driver, delays at rail/highway crossings are reported. In the case of a delay of significance to patient outcome, the dispatcher radios the police department or the rescue squad for assistance. In addition to receiving calls for assistance from the ambulance service, the rescue squad is dispatched to all life-threatening medical emergencies reported through the City's 911 emergency telephone system. Both the police and the rescue squad members are trained in emergency medical treatment; the rescue squad vehicle is equipped with life-support equipment. Thus, the rescue squad or the police can provide first-response aid to victims until the ambulance service arrives. Since its inception, the rescue squad has responded to 125 medical emergencies annually or about nine percent of all medical emergencies that occur each year. During this period, no crossing delays have occurred which have adversely affected victims.

Intersection Improvements. In Sauk Rapids, improvements to a major intersection adjacent to the main line crossing were made to improve traffic flow. While not low-cost compared to other demonstration projects (the improvements cost $1 million), intersection improvements are much less expensive than grade separations or rail relocations. This project enabled the effect of the improvements on traffic delays associated with railroad operations to be assessed. Modifying an intersection in Elk River was recommended as a demonstration project, but has not yet been implemented. Because more extensive changes to the Elk River intersection may be implemented in the next few years, Mn/DOT decided to postpone possible implementation of the demonstration project.

In Sauk Rapids, major improvements to the primary intersection in the city were completed in 1981. The improvements included widening approaches in all directions, changing traffic channelization, and introducing a new traffic signalization system. The BN main line is located about 100 feet west of the intersection. A comparison of traffic flows through the intersection before and after the improvements indicates delays associated with railroad operations have been reduced. Vehicles delayed by trains were observed to clear the intersection after a train has passed in almost half the amount of time as before (48 seconds versus 81 seconds on average). Also, normal traffic flow subsequent to a train's departure was restored more quickly. Overall, the improvements have resulted in an 8 to 10 percent reduction in the number of vehicles delayed, a 15 to 30 percent reduction in average delay per vehicle, and a 20 to 35 percent reduction in total vehicle delay time in the 15-minute period subsequent to train departure. The total reduction in vehicle delay time is 9.3 vehicle hours (about 13 person hours) daily.

In Elk River, delays at the intersection are caused when motorists wanting to cross the adjacent main line are blocked from doing so by rail operations. Because of inadequate road capacity for vehicles wishing to turn at the intersection, the vehicles waiting to cross the main line congest the intersection, causing delays to through traffic which would bypass the blocked crossing if road capacity were sufficient. The congestion filters into the adjacent central business district and disrupts business activity. The traffic movements resulting from congestion (frequent stops and starts, use of the wrong lanes to bypass waiting vehicles) increase the accident potential of the intersection. Another problem at this intersection is the lack of adequate traffic signal coordination, which sometimes results in trapping motorists between the crossing gates when a train is approaching.

The recommended improvements would have increased intersection capacity within the existing right-of-way. The recommendations included (1) removal of on-street parking to allow turning lanes to be established, (2) redesign of an off-street parking lot, and (3) installation of a new system to improve the flow of traffic through the intersection and to resolve the "trapped motorists" problem. These improvements were estimated to cost about $25,000 and were expected to reduce vehicle delay at the intersection by 15 to 40 percent. Safety conditions also were expected to improve.

Rail Siding Changes. In Beach, siding modifications, which will include installation of power switches at each end of the siding, will be made within the next two years. Already implemented is an operating policy to generally reduce the use of the siding in Beach. This policy has been made possible by the lengthening of sidings east and west of Beach to accommodate longer trains. The siding changes will reduce vehicle delay at crossings in Beach in several ways. Restricting use of the siding to one train will mean that trains need not block the crossings while occupying the siding. (Currently, when two trains are in the siding, one often must block the crossings because of limited siding capacity.) Installation of a power switch will eliminate the need for the train to be stopped in the town while a crewman throws the lead switch, permitting the train to enter or exit the siding. Remote control provided by power switches will allow trains to maintain speeds up to 25 mph when entering and exiting the siding. Restricting siding use to one train also will allow more siding distance for accelerating and decelerating the train, again resulting in increased train speeds through the town. The expected overall reduction in general traffic and emergency service delays at crossings in Beach is 25 percent. A five percent reduction in delay has been accomplished to date.

Similar results are expected to occur in Hebron. It was recommended that the siding in Hebron be lengthened to permit trains to stop farther from the crossings and provide more distance for acceleration and deceleration. Installation of power switches under Burlington Northern's proposed centralized traffic control program also will permit faster train speeds entering and exiting the siding through town. These changes have been postponed by Burlington Northern pending traffic increases. Siding alterations in Hebron will cost $360,000; those in and near Beach will exceed $600,000 when completed. Given that the siding changes are a component of the Burlington Northern's capital improvement program to increase main line capacity and to increase operating efficiency, these projects reveal how a capital improvement program which is sensitive to rail/community conflicts can accomplish community as well as railroad objectives.

Safety Education. A safety education program was conducted in Casselton schools in response to the concern for the safety of children who cross the main line while walking to and from school and to and from the recently completed public swimming pool. The program, conducted by the police chief, was undertaken to increase the precautions taken by children when crossing the main line. The program has not been effective in the opinion of local officials, primarily because of its limited scope and follow-up. A second safety project, construction of a fence along the railroad right-of-way in Hebron to discourage pedestrians, mainly children, from crossing the main line at locations other than signalized crossings, was not implemented. Further study revealed that available locations for the fence substantially compromised its effectiveness as a safety measure.

Grade Crossing Predictors. Installation of grade crossing predictors (GCPs) is an action that was implemented in all six case study communities. At crossings where current protection is provided by flashing lights or crossbucks, automatic gates were installed along with the GCPs.

GCPs reduce rail/community conflicts through the elimination of early signal activation. Previously, grade crossing warning signals in the communities were activated by circuits located a set distance from each crossing. When the train entered the section of track containing the circuit, the crossing warning signals were activated. The distance of the circuit from the crossing was determined by the maximum allowable train speed through the crossing. Most states require that crossing signals be activated at least 20 seconds prior to the time the fastest train would arrive at the crossing. This means that trains moving slower than the maximum allowable speed will activate signals often considerably in excess of 20 seconds before train arrival. For example, a train moving at 5 mph may activate the signals 6 minutes or more before it enters the crossing. Also, trains that enter the track circuit and then stop activate the signals until they start again and move through the crossing. The activation of signals a considerable time before train arrival at the crossing is referred to as "early signal activation."

Early signal activation contributes to rail/community conflicts in three ways. First, it increases the amount of time crossings are closed to vehicular traffic. In some communities, a significant portion of the blocked crossing time (up to 40 percent) is the result of early signal activation. Second, early signal activation has resulted in frequent violation of warning signals by motorists and has thus reduced the credibility of warning signals, and hence, their effectiveness. Finally, early signal activation is aggravating to community residents and heightens rail/community conflicts in general.

GCPs eliminate early signal activation by determining the speed of the approaching train and activating the signals at a set time interval prior to train arrival at the crossing (usually 25 to 35 seconds). In this way, vehicle delay and safety problems associated with early signal activation are reduced.

A comparison of crossing delays in the case study communities before and after installation of the GCPs reveals that the expected improvement, a reduction of 10 to 25 percent, depending on the community, has occurred. According to the observations, the GCPs have resulted in a 5 to 30 percent reduction in the probability of delay. The duration of delay also has been reduced, resulting in an overall reduction in vehicle hours of delay ranging from 10 to 45 percent. Delay due to emergency services has been similarly reduced.

The variation in results among the communities is a function of the amount of early signal activation experienced before the GCPs were installed. In communities experiencing slow-moving trains, delayed trains, and/or significant local switching operations, early signal activation is a large component of blocked crossing time. In these communities, GCPs can effect a large reduction in delay occurrence and duration. In communities experiencing more through train movements at relatively faster speeds, GCPs have a less substantial effect on delay.

To establish the effectiveness of GCPs in reducing rail/highway crossing accidents requires several years of accident statistics. The reason is that crossing accidents occur infrequently in a given community; thus, a sample size large enough to establish statistically verifiable results requires several years to obtain. Since the GCPs were installed in the case study communities only within the last year, an adequate accident history is not yet available. 3/

Another way to measure the effectiveness of GCPs in reducing crossing hazards is the number of traffic violations involving motorists' crossing the main line against the warning signals. This is a reasonable indicator of safety improvement because the major safety reason for installing GCPs is to reduce this motorist behavior. Observations of motorist behavior in the case study communities reveal that the number of times motorists cross against warning devices has declined significantly since the GCPs were installed. In Moorhead, the percentage of violations observed declined by 50 to 90 percent at the crossings with GCPs. For crossings at which GCPs were not installed, the number of violations actually increased by 20 percent. In the other case study communities, although crossing violations were reported as a frequent occurrence, none

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3/ An alternative evaluation method would be to compare the accident history at crossings with GCPs and without GCPs. The crossing inventory and accident data maintained by the Federal Railroad Administration may provide an initial data base for this analysis.

were recorded during the Phase III observation period. These observations suggest that the expected improvement in crossing safety (i.e., a 40 percent reduction in accidents) may indeed result from installation of GCPs.

Similarly, determination of safety improvements resulting from installation of automatic gates requires a longer observation period than has elapsed to date. However, the effectiveness of automatic gates is well-established from previous research. The research indicates that gates are generally 45 percent more effective than flashing lights and 90 percent more effective than crossbucks as a warning device. This order of magnitude reduction in crossing accidents can be expected over time in the case study communities in which automatic gates were installed.

The costs of installing GCPs ranged from $45,000 to $75,000 per crossing. Installation of GCPs with automatic gates cost from $65,000 to $100,000 per crossing. GCPs also cost about $300 more per year to maintain than distance-activating circuits; automatic gates may cost about $500 per year more to maintain than lesser devices. Offsetting the costs is the reduction in safety hazards, which reduces the railroad's liability and associated costs.

Increasing Train Speeds. In Moorhead, two actions were implemented to increase train speeds through the City in an effort to reduce access delays to the central business district (CBD). The actions include (1) installation of a power switch to replace the manual switch at the lead to the Burlington Northern's Dilworth yard just east of Moorhead and (2) changing signal circuitry on the main line to permit an increase in the maximum allowable train speed from 25 to 35 mph. The actions were implemented only on the southern line of the two parallel main lines bordering the CBD and separating it from the residential community. The southern line experiences 80 percent of the rail operations and separates 75 percent of the population from the CBD. (A more even distribution of trains between the main lines was investigated but found to be expensive and ineffective in reducing CBD access problems.)

It is apparent that an increase in maximum allowable train speed will decrease the amount of time crossings are blocked. (Therefore, the amount of vehicle delay will decrease.) The power switch also permits faster train speeds through Moorhead and thus contributes to a reduction in crossing delays. This is accomplished by eliminating the stop/start movements required to operate the existing manual switch and enter the yard. That is, entrance to Dilworth yard used by eastbound, nonlocal trains was controlled by a manually operated switch. The manual switch required a train to stop, a crewman to throw the switch manually, and the train to proceed through the switch and to stop again while the crewman returned the switch to its original position and rejoined the train. The power switch provides for remote control of the switch and permits maintenance of 25 mph while entering the yard.

As a result of these actions, the average train speed on the southern main line in Moorhead is now 29 mph, versus 20 mph before the changes. The increased train speed, in turn, has resulted in a 45 percent reduction in vehicles delayed at crossings on the line. Because the actions were not implemented on the northern main line, which also bounds the CBD, overall CBD accessibility has improved by a smaller amount, 27 percent. Emergency services also will benefit from the increased train speeds. It is estimated that about 25 percent fewer ambulance, fire, and police service delays will be experienced because train speeds were increased. The capital cost of implementing the actions was about $60,000. The railroad will experience a net annual operating savings of $90,000 as a result of the increased train speed.

Community/Railroad Communications. In all communities, an effort was made throughout the study to improve general community/railroad communications. Discussions with communities while carrying out Phases I and II of the study revealed that there have been misunderstandings, misperceptions, inaccurate data and assumptions, and frustration with communication breakdowns between communities and the railroad. The repercussions of the communication problem were apparent, for example, when some community officials questioned the motivation behind actions taken by the railroad to reduce rail/community conflicts. The resulting confusion heightened community animosity toward the railroad and worsened perceptions of the rail/community conflicts. Similarly, the absence of clear communication channels has led communities either (1) to report problems to the wrong railroad official, resulting in no railroad response to the community complaint or (2) to fail to report problems at all. The resulting frustrations needlessly fuel the rail/community conflicts.

Using the Rail Corridor Study as a vehicle, the communities and the railroad have established clearer channels of communication and more frequent interaction. The opinion of most community and railroad officials is that the effort has been successful and worthwhile. Both sides are more aware of each other's problems and constraints and are acting more cooperatively to resolve problems. The railroad in particular has actively pursued resolution of rail/community conflicts in the case study communities and in numerous other corridor communities through the introduction of capital improvements, the changing of operating practices, and the provision of project funding. Railroad officials report that increased involvement in rail/community conflict resolution provides professional as well as personal rewards.

The one demonstration project that was not well-received by community residents is the closing of a crossing in Casselton. The crossing is closed to vehicular traffic, but is being maintained as a pedestrian crossing. It is part of the effort to reduce crossing accidents. Automatic gates and GCPs were installed at the other three crossings in the community. It is the policy of the State of North Dakota, when deciding crossing improvements, to consider the possibility of closing one or more crossings in a community while upgrading others. The policy is predicated in part on a community-wide approach to improving crossing safety (to funnel traffic to crossings with the most effective warning devices) and in part on economics (the allocation of limited resources among crossings and communities in the State). For these reasons, and based on the finding that the closing would have a marginal effect on traffic patterns and travel times, a decision was made to close the crossing.

Residents of Casselton are appealing the decision. The residents contend that the closing has reduced accessibility within the community to both pedestrians and motorists, has increased crossing hazards, and has had an adverse environmental effect on the community. This has been true because of an unexpected effect of the demonstration projects, for which remedial actions have been taken. Trains delayed in Casselton tended to stop across or near the closed crossing (they previously stopped outside of Casselton). This created a visual obstruction to trains using the second main line track. Also children were observed to crawl between train cars when this occurred. The tendency of delayed trains to stop near the crossing increased the perceived noise levels in the town as well. Whereas trains previously started to accelerate outside of town, they were accelerating within town causing increased noise levels. In addition, train speeds through town were lower as a result of this practice and caused longer blocked crossing time. Burlington Northern has taken steps to ensure that trains will resume the practice of stopping outside of Casselton when delayed, which should resolve the residents' concerns. Other reasons the residents opposed the crossing closing are the following:

1. There is less direct access between some parts of the community--one must now travel two additional blocks for some trips, incurring less than one minute additional travel time;

2. Traffic has increased at the crossings that were not closed--650 cars daily; and

3. There are no warning signals at the portion of the crossing maintained for pedestrians, mostly children and elderly persons. In time, these concerns may be alleviated by the rail/community conflict improvements resulting from the demonstration projects.

CASE STUDY COMMUNITY RESULTS

A summary of the extent to which the demonstration projects have reduced problems in each case study community is presented in Exhibit 8. Exhibit 9 shows the contribution of each demonstration project to community problem reduction. The results reveal considerable variation among communities in the extent to which rail/community conflicts have been

EXHIBIT 8

REDUCTIONS IN RAIL/COMMUNITY CONFLICTS ACTIVATED BY THE DEMONSTRATION PROJECTS

Community	Vehicular Delay		Emergency Service Delays	Expected Crossing Accidents
	# Delayed	Delay Time		
Beach, ND	-15%	-30%	-15%	-75%**
Casselton, ND	-15%	-30%	-70%**	-70%**
Elk River, MN	-25%	-55%	-50%**	-35%**
Hebron, ND	-25%	-45%	-25%	-70%**
Moorhead, MN	-30%	-50%	-100%** (medical emergencies)	-35%**
Sauk Rapids, MN	-15%	-35%	-100%** (medical emergencies)	-10%**

* Estimated annual change in problem magnitude resulting from the demonstration projects.

** Further observations are required to verify these estimates.

EXHIBIT 9

REDUCTIONS IN RAIL/COMMUNITY CONFLICTS BY COMMUNITY AND BY DEMONSTRATION PROJECT

Community	Actions Taken	Emergency Service Delays	Vehicular Delays # Delayed	Vehicular Delays Delay time	Crossing Accidents
Beach, ND	GCPs and gates were installed at the crossings	-10%	-10%	-20%	-75%*
	Sidings outside of the community were lengthened in order to reduce the number of trains using the Beach siding	-5%	-5%	-10%	N/A
Casselton, ND	Automatic gates were installed at the 3rd and 6th Avenue crossings. The 8th Avenue crossing was closed to vehicular traffic but maintained as a pedestrian crossing. GCPs were installed at all crossings.	-15%	-15%	-30%	-70%*
	An emergency service/railroad communication system was established.	-65%	N/A	N/A	N/A
	A safety education program was conducted in the schools.	N/A	N/A	N/A	No effect
Elk River, MN	GCPs were installed at all crossings. The crossings already had automatic gates.	-25%	-25%	-55%	-35%*
	An emergency service/railroad communication system was established.	-30%; Not fully tested*	N/A	N/A	N/A
Hebron, ND	GCPs and automatic gates were installed at all community crossings.	-25%	-25%	-45%	-70%*

EXHIBIT 9 (Cont.)

Community	Actions Taken	Emergency Service Delays	Vehicular Delays # Delayed	Vehicular Delays Delay time	Crossing Accidents
Moorhead, MN	A power switch was installed in place of the manual switch at the Dilworth Yard lead.	-5%	-5%	-10%	N/A
	The allowable train speed was increased from 25 mph to 35 mph.	-20%	-20%	-30%	0%*
	GCPs were installed at all crossings on the southern main line.	-5%	-5%	-10%	-35%*
	An emergency service/railroad communication system was established.	Not fully tested	N/A	N/A	N/A
	A rescue squad was previously established.	-100% (medical emerg.)	N/A	N/A	N/A
Sauk Rapids, MN	Improvements were made to the TH15/Benton Drive intersection.	-8%	-8%	-25%	N/A
	GCPs were installed at the 1st Avenue South Crossing.	-7%	-7%	-10%	-10%*
	An emergency service/railroad communication system was established.	-100% (medical emergencies)* not fully tested	N/A	N/A	N/A

Estimated annual change in problem magnitude resulting from the demonstration projects. Estimates with an asterisk require further observation to verify. "N/A" indicates that the project was not applicable to the problem.

reduced. There also is considerable variation in the effectiveness of individual demonstration projects among communities. These variations are a function of (1) community characteristics--service characteristics and development and activity patterns, and (2) railroad characteristics--operations and facilities. Together, these characteristics determine whether implementation of a given low-cost action is feasible and the extent to which the action can reduce rail/community conflicts.

The emergency communication system, established in four of the communities, provides an example. To determine the feasibility and effectiveness of the communication system, a simulation model was developed. The model determines if sufficient time is available to alter train operations, before the emergency service provider must cross the main line, in order to avoid emergency service delay. The critical variables in the model are train characteristics (size, speed, and location) and emergency service characteristics (location of the vehicle and the staff, response time). Using the model, it was determined that in some communities (Beach and Hebron) the amount of time from the receipt of an emergency call to the crossing of the main line was not sufficient to alter train operations. An attempt to alter train operations could lengthen rather than reduce delay time. In other communities (Casselton and Elk River), train operations could not be altered in time to circumvent delays to volunteers as they travel to the station, but they could be altered to avoid delays from the station to the emergency site and then to the hospital. In these cases, only a portion of the delays could be circumvented. Finally, in one case (Sauk Rapids), response time is such that all emergency service delays can be circumvented.

GCPs were installed at crossings in each case study community. The reduction in vehicles delayed at crossings which is attributable to the GCPs ranges from 5 to 30 percent. This range is directly related to the magnitude of early signal activation experienced in each community before the GCPs were installed. As discussed earlier, GCPs reduce crossing delays by eliminating early signal activation. Consequently, the effectiveness of the GCPs is limited by the magnitude of early signal activation.

Early signal activation is a function of train speeds and the location of the circuit which activates the crossing signals. In a community in which train speeds do not vary significantly, the circuit can be located such that the signals are activated in a relatively short time, on average, prior to a train's arrival at the crossing. This is the case, for example, in Moorhead where the average signal time prior to train arrival was 1 1/4 minutes. In such cases, the contribution of early signal activation to blocked crossing time is small and there is little opportunity for GCPs to reduce blocked crossing time. In Moorhead, early signal activation accounted for only 5 percent of the blocked crossing time (after train speeds were increased). Consequently, the installation of GCPs in Moorhead resulted in reducing vehicle delays at crossings by only 5 percent. In contrast, early signal activation in Elk River accounted for almost 30 percent of the blocked crossing time. This was due to a wide range in train speeds through the City. Through trains operated at speeds up to 45 mph through Elk River, some local trains conducted lengthy, slow-moving operations. Consequently, the installation of GCPs in Elk River effected a considerable reduction in blocked crossing time (30 percent) and hence, in crossing delays.

Similar differences in community and railroad characteristics among the case study communities dictated different approaches to reducing rail/community conflicts, which resulted in different amounts of problem reductions. In Beach, Casselton, and Hebron, automatic gates, as well as GCPs, were installed, resulting in larger reductions in expected crossing accidents than in communities in which only GCPs were installed. In the latter communities, the crossings were equipped with gates prior to the study, leaving less opportunity to reduce accident potential.

Only in Moorhead was there an opportunity to significantly increase the speed of through trains. Speeds were increased from 20 to 29 mph, on average, resulting in a 20 percent reduction in blocked crossing time and vehicle delay. In the other communities, through train speeds already were as high as permitted by safety standards, or the communities were reluctant to allow increases in train speeds. (The communities' primary concern with respect to increasing train speeds is crossing safety. Research indicates, however, that crossing hazard is not statistically correlated with train speed.) Moorhead also had the opportunity to install a power switch in place of a manual switch at the lead to the Dilworth yard, because a centralized train control system (CTC) is in place. The switch contributed to increased train speeds through the City, and thus to reduced crossing delays. Power switches at the sidings in Beach and Hebron also have been proposed but cannot be installed until CTC is extended to these locations. Installations of the power switches and other siding changes in Beach and Hebron may result in a 25 percent decrease in crossing delays.

The changes presented above represent observed and projected reductions in problem magnitude. Another concern in evaluating the demonstration projects is the change in community residents' perceptions of problem magnitudes that has occurred since the projects were implemented. This was determined by comparing community residents' responses to a mail survey conducted at the outset of the study and again at study completion. Recipients of the survey were asked their opinion with respect to the severity of problems associated with rail/community conflicts.

There are limitations to comparing the before and after opinions of those who responded to the survey. One limiting factor is that railroad operations experienced during the time each survey was administered may have differed. This could not be determined without a lengthy period of railroad operations observation, which was beyond the study resources. Also, one demonstration project, establishment of emergency communication systems in four communities, was not implemented until after the survey was administered. Consequently, the residents' opinions with respect to emergency service delays do not reflect the substantial reduction in delays expected to result from the communication systems. Despite these limitations, a comparison of the survey results is instructive.

Responses to the survey by community are presented in Exhibit 10. The priority problems in each community (the problems the demonstration projects were designed to mitigate) are enclosed in boxes. Statistically significant changes in opinions are identified with asterisks; other entries are interpreted as no change in residents' perceptions of problem magnitude.

EXHIBIT 10

RESIDENTS' OPINIONS OF PROBLEM SEVERITY--
PHASE I AND PHASE II SURVEY RESULTS

	Percentage of Respondents Who Perceive the Problem To Be Serious 1/2/						
	VS	PS	EVD	AWS	ASR	EN	CD
Beach							
Before	77%	58%	73%	42%	38%	15%	14%
After	35*	19*	62*	21*	18*	19	8
Casselton							
Before	45	32	52	18	12	13	9
After	25*	34	66*	22	16	38*	17*
Elk River							
Before	35	29	33	11	13	13	20
After	22*	13*	38	16	8	13	20
Hebron	Not surveyed						
Moorhead							
Before	15	13	40	22	11	19	20
After	12	6	45	17	13	5*	8*
Sauk Rapids							
Before	41	24	47	23	19	23	16
After	23*	11*	35*	14	7*	16	16

1. Legend
   VS = vehicle safety
   PS = pedestrian safety
   EVD = emergency service delay
   AWS = access to work and school
   ASR = access to shopping and recreation
   EN = environmental disturbance
   CD = community development

2. An asterisk indicates that the change is statistically significant at the 90 percent confidence level.

Comparison of respondents' opinions before and after the demonstration projects were implemented indicates that residents perceive improvement in 60 percent of the priority problems addressed. From 37 to 67 percent fewer respondents perceive these problems to be serious since the projects were implemented. If the emergency service delay problem is eliminated from the comparison (for those communities in which the effects of the emergency communication system have not yet been realized) the percentage of priority problems improved is 80 percent.

While significant improvements in most priority problems have occurred, non-priority problems have been reduced or have not been changed since the last survey was taken, according to the respondents. The exception is in Casselton. Residents of Casselton perceive a worsening of rail/community conflicts for the reasons previously explained.

Three additional observations can be made concerning changes in perceived problem magnitude. One observation is that respondents from communities in which demonstration projects were highly visible (i.e., Beach and Sauk Rapids) perceive more significant changes than respondents from other communities. In Elk River and Moorhead, less than 30 percent of the respondents were aware of the actions taken to reduce problem magnitudes, according to survey responses. In Beach and Sauk Rapids, an average of 70 percent of the respondents were aware of the actions taken. This result suggests that an effort to educate the public of actions taken could change residents' perceptions of problem magnitudes.

Another observation is that statistically significant changes in perceived problem magnitude tend to correspond directly to the percentage of respondents who perceived the problems to be serious in the original survey. This result is due in part to the nature of the test of statistical significance. A larger change in opinion is required for a finding to be statistically significant when the percentage of respondents who perceive a problem to be serious is small. Also to be kept in mind is that the problems with which there was less concern (i.e., those which fewer respondents identified as serious) were not the target of the demonstration projects. Less change in these cases would be expected.

A third observation is that in some communities, some segments of the population benefited more than others from the demonstration projects. These significant sub-community improvements are not apparent in a community-wide survey. An example occurs in Elk River. Whereas the general public perceives no change in accessibility to work and school, school officials reported the elimination of lengthy school bus delays which used to occur regularly. Similarly, in Moorhead, the demonstration projects were implemented on only one of the main lines. This may explain why survey respondents perceive a significant reduction in the community development problem (i.e., accessibility to the business district) but not in general accessibility throughout the community.

Overall, the evaluation reveals that the demonstration projects have resulted in priority problem reductions which are measurable from observation and which in the majority of cases are perceived by community residents as significant changes.

APPLICABILITY OF DEMONSTRATION PROJECTS TO OTHER COMMUNITIES

The experience of the case study communities is instructive to others. Certain preconditions, defined in terms of community and railroad characteristics, must exist for specific low-cost actions to be feasible.

Community and railroad characteristics also will determine the extent to which a given low-cost action will reduce rail/community conflicts. These conditions are summarized in Exhibit 11. The information presented in the exhibit can be used to determine opportunities to reduce conflicts in other corridor communities.

It is important to understand that the information presented in Exhibit 11 is restricted to the low-cost actions specified. If the pre-conditions listed do not prevail in a community, it is possible that these specific low-cost actions may be unfeasible or ineffective in that community. However, it would be an inappropriate conclusion that nothing could be done to reduce rail/community conflicts in the community. Other low-cost actions are available, such as those listed in Exhibit 7 earlier in this report.

CONCLUSIONS

The Rail Corridor Study has made several significant advances in the understanding of rail/community conflicts and of the potential for low-cost actions to reduce these conflicts. The basic problems associated with the conflicts have been defined and the factors which contribute to them, including the role of unit coal trains, have been clarified. Analytical methods and procedures have been developed which provide for accurate problem identification and assessment and for alternatives analysis.

Most significantly, the implementation and review of several demonstration projects has shown that low-cost actions can effect significant reductions in rail/community conflicts. Through a variety of actions,

EXHIBIT 11

APPLICABILITY OF DEMONSTRATION PROJECTS TO OTHER CORRIDOR COMMUNITIES

Demonstration Project	Preconditions For Feasibility	Potential Results
Grade Crossing Predictors	Significant amount of early signal activation, e.g., in excess of one minute per train.	Is strictly a function of the amount of early signal activation. Most effective in situations with a mix of slow and fast train speeds, with significant local switching, and/or with frequent train delays.
	Frequent motorist violation of warning signals at crossings.	Reduction of 40 percent or more in violations and hence in accident exposure.
Automatic Gates	Lesser current crossing warning devices, e.g., flashing lights or crossbucks.	Reduction in expected accidents ranging from 45 percent (replacing flashing lights) to 90 percent (replacing crossbucks).
Power Switch	Centralized train control system.	Is a function of the number of trains using the switch and the amount of time crossings are blocked when the switch is used. Is particularly effective when the switch is located within the community. Blocked crossing time may be reduced by 6 minutes or more per mile-long train.
Emergency Communication System	Sufficient lead time (i.e, time from receipt of emergency call to time that rail line is crossed) to alter train operations. Train speeds less than about 40 mph. For speeds in excess of 40 mph, the potential crossing delay is small.	In situations in which the lead time is 3 minutes or longer, all potential delays may be circumvented. If lead time is less than 3 minutes, the communication system may be useful only to reduce particularly lengthy delays, e.g., when a switching operation is being conducted or a train is stopped in or near the crossing.
Increase Train Speeds	Current train speeds held below safe operating speed.	Applies only to through trains and is a function of the current average speed and the increased speed. E.g., a change from 20 mph to 30 mph would reduce delay per train by about 33 percent; a change from 30 mph to 40 mph would reduce delay per train by 25 percent.
Siding Changes	An existing siding in or near the community.	Is a function of the type and frequency of siding use.
Rescue Squad	Sufficient number of volunteers or sufficient budget to hire a paid staff.	Is a function of the number of potential emergency service crossing delays annually and the probable duration of delay. Many rural communities served by distant ambulance services establish rescue squads regardless of crossing delay problems.
Intersection Improvements	A major intersection adjacent to a main line crossing.	Is a function of the spill-over effect of crossing delays on traffic flow through the intersection and the frequency of occurrence.

vehicular delay in the case study communities has been reduced by 15 to 30 percent. Because the average duration of delay per vehicle also was reduced, vehicular delay time was reduced by a larger amount, from 20 percent to 55 percent, depending on the community. Delays to emergency services also have been reduced by at least as much as was vehicular delay. Further reductions (up to 100 percent in one case) are expected to result from the emergency communication systems. More experience with the systems is required before a definitive conclusion concerning their effectiveness can be made. Finally, reductions in crossing accidents ranging from 10 to 75 percent are expected to result from the demonstration projects. Importantly, community residents perceive these problem reductions to be significant improvements in most cases. These impressive reductions in rail/community conflicts were achieved at an average project cost of $130,000; half of the projects cost under $70,000. The range in cost per community was $115,000 to $640,000, excluding the million-dollar intersection improvement made in Sauk Rapids.

The results achieved in the case study communities can be achieved in other communities as well, through the application of similar or new low-cost actions. Low-cost actions will not solve all problems in all communities. In some communities, the actions may render problems more manageable while more costly solutions are formulated. In other communities, low-cost actions will be ineffective and can serve no function. The demonstration projects reveal, however, the exciting potential for low-cost actions to reduce or substantially resolve problems associated with rail/community conflicts.

* U.S. GOVERNMENT PRINTING OFFICE: 1982 361-428/2002

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